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(54) Rubber composition for tyre tread

(57) A rubber composition for a tyre tread, having good abrasion resistance and good balanced performances of traction, braking and cornering. The rubber composition is obtained by mixing 100 parts by weight of at least one rubber component selected from the group consisting of a natural rubber, an isoprene rubber and a butadiene rubber, 5 to 45 parts by weight of a silica, 0.5 to 4.0 parts by weight of a silane coupling agent and 3 to 8 parts by weight of a powdered article containing cellulose material.

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Description

- [0001] The present invention relates to a rubber composition for a tyre tread, which can provide a tyre having good in abrasion resistance and balanced performance of traction property, braking property and cornering property.
- 5 [0002] As a factor controlling friction between tread rubber and road surface, which has an effect on the grip property of tyre, examples thereof are adhesive friction, digging friction and hysteresis friction.
- [0003] In order to improve the adhesive friction by softening the tread rubber and increasing the contact area between the tread rubber and the road surface, it has been proposed to decrease the amount of filler in a rubber composition for the tyre tread, to use a butadiene rubber or an isoprene rubber which do not simply harden at low temperature, or to
- 10 add a softening agent. But in each of these cases, there arises the problem that the resultant tyre is lacking in handling stability and abrasion resistance.
- [0004] From the viewpoint of maintaining handling stability and abrasion resistance, it has been suggested to improve the wet grip property and the ice grip property, to increase the adhesive friction by decreasing the modulus at low temperature by using both silica as a part filler (carbon black) and a silane coupling agent (Japanese Unexamined Patent Publication No 73657/1996). In this case the cornering property of the obtained tyre is improved, but the traction property and the braking property are not improved sufficiently.
- 15 [0005] On the other hand, in order to improve the digging friction, it has been investigated to use a rubber foam as a rubber component and to use an organic fibre. In these cases the traction property and the braking property are improved, but the cornering property is not improved sufficiently.
- 20 [0006] In order to improve hysteresis friction, it has been proposed to employ a styrene-butadiene rubber and to increase the amount of filler. But then there arises the problem that the hardness becomes too high without relation with property on snow and ice.
- [0007] So there is still not provided a rubber composition for a tyre tread having good abrasion resistance and balanced performances of traction, braking and cornering properties.
- 25 [0008] It is an object of the present invention to provide a rubber composition for a tyre tread, having good abrasion resistance and balanced performances of traction, braking and cornering.
- [0009] According to one aspect the present invention provides a rubber composition for a tyre tread comprising 100 parts by weight of at least one rubber component selected from the group consisting of a natural rubber, an isoprene rubber and a butadiene rubber, 5 to 45 parts by weight of a silica, 0.5 to 4.0 parts by weight of a silane coupling agent
- 30 and 3 to 8 parts by weight of a powdered article containing cellulose material.
- [0010] The average particle diameter of the above-mentioned powder articles is preferably 20 to 600 μm .
- [0011] Another aspect of the present invention provides a truck and bus tyre using the rubber composition for a tyre tread.
- 35 [0012] The rubber component employed in the present invention is at least one rubber selected from the group consisting of a natural rubber (NR), and a butadiene rubber (BR) from the viewpoint of reinforcement and properties at low temperature.
- [0013] In the case of a combination use of two or more thereof, the combination ratio can be suitably selected by the person skilled in the art. The combination ratio of NR and BR may be 100-0:30-70 (weight ratio).
- [0014] For the silica employed in the present invention, the conventional silica employed in the tyre field can be
- 40 employed without particular limitation.
- [0015] Market place examples thereof are, for instance, Ultrasil VN3 (available from Degussa Japan Co Ltd), Nipsil VN3 (available from Nippon Silica Co Ltd), Nipsil AQ (available from Nippon Silica Co Ltd), Tokusil UR (available from Tokuyama Corporation), Z1115Np (available from RHÔNE-POULENC CO), Z1165Mp (available from RHÔNE-POULENC CO) and the like.
- 45 [0016] The amount of silica is 5 to 45 parts by weight based on 100 parts by weight of the above-mentioned rubber component. From the viewpoint of balance of snow and ice performance and abrasion resistance, the amount is preferably 10 to 40 parts by weight, and even more preferably 20 to 30 parts by weight.
- [0017] For the silane coupling agent employed in the present invention, the conventional silane coupling agent can be employed without particular limitation. Examples thereof are bis(3-triethoxysilylpropyl)tetrasulfen, a-mercaptopropyltrimethoxysilane, 3-thiocyanatepropyltriethoxysilane, bis(3-triethoxysilylpropyl)disulfen and the like.
- 50 [0018] The amount of the silane coupling agent in the present invention is 8 to 10% by weight from the viewpoint of the effect of reinforcement and the higher cost.
- [0019] The powdered article containing cellulose material employed in the present invention is described in Japanese Patent No 2554536. Examples thereof are rice husks, wheat husks, pieces of cork, sawdusts and the like. The powdered articles may contain a silica, a clay, a woody component, a fatty acid, water and the like as the component except for cellulose material.
- 55 [0020] Japanese Patent No 2554536 discloses a rubber composition containing the above-mentioned powdered article, but it does not refer to using of a silica as a filler or the same rubber composition of the present invention or a silane

coupling agent.

[0021] It is easy for the powdered article to be dispersed in the mixing process, since it contains cellulose in its component and the compatibility with the rubber is good. The article is lost from the tread surface easily due to abrasion when running. But the tear strength is not lowered and a crack in the tread is not formed easily, since it forms a weak bond with the rubber.

[0022] There is no problem of abrasion of the paved road surface when using a material having a higher hardness as a metal, and no problem of decrease in an adhesive effect with the surface of the frozen road due to increase of the hardness of the total rubber. On the other hand, spike or mechanical grip is not sufficiently demonstrated if a material having a lower hardness than the cellulose is used. The hardness of ground plants such as rice husks, wheat husks, pieces of cork, sawdusts and the like, is suitable from this point of view. Among these the rice husks are more preferable, since the hardness of rice husks is suitable. Since the rice husks as a natural product are powders having unevenness, they are compatible with rubber and provide the properties that not only tear strength but also the crack performance of the tread are not lowered.

[0023] The average particle size of the powdered article is preferably 20 to 600 μm , more preferably 100 to 200 μm . If the diameter thereof is below 20 μm , the desired spike effect is not sufficient. If the diameter thereof is above 600 μm , reinforcement and abrasion resistance become poor. Also the adhesive effect (grip performance on ice) is apt to decrease, since the surface of the tread after running easily becomes rough and the contact area of the rubber with an ice surface becomes less. From the viewpoint of balance of reinforcement and performance, the diameter is particularly more preferably 100 to 120 μm .

[0024] The amount of the powdered article containing cellulose material in a rubber composition is preferably 3 to 8 parts by weight based on 100 parts by weight of the rubber. If the amount is below 3 parts by weight, it is difficult to demonstrate the desired spike effect sufficiently. On the other hand, if the amount is above 8 parts by weight, the adhesive effect is apt to decrease and the abrasion property tends to be insufficient, since the powdered articles themselves are in contact with the road surface due to the hardness of rubber and the contact area with the base rubber and the ice surface becomes less.

[0025] To the rubber composition of the present invention can be suitably added, except for the above-mentioned components, for example, a filler such as talc, clay and carbon black; a softening agent such as a process oil of paraffin, aromatic, naphthene; a tackifier such as a coumarone indene resin, a rosin resin and a cyclopentadienyl resin; a vulcanising agent such as sulfur and peroxide; an accelerator; a vulcanising assistant such as stearic acid and zinc oxide; an antioxidant and the like, if necessary in the range of not losing the object of the present invention.

[0026] The rubber composition of the present invention can be obtained by the conventional method using a Banbury mixer, an open roll or the like.

[0027] The rubber composition of the present invention obtained by the above-mentioned method can be preferably employed as tyre tread.

[0028] A tyre with the rubber composition employed as tyre tread, especially a studless tyre, shows a spike effect by the method that the powdered article containing cellulose material harder than the base rubber which exists on the surface of tread rubber scratches the road surface when running on a frozen road, particularly in braking, accelerating and circling. The grip performance on ice is clearly drastically improved, since an opening, an unevenness and an edge, formed on the surface of the tread by loss of the powdered article from the surface of the tread due to the abrasion, improves friction with the surface of ice.

EXAMPLES

[0029] The present invention is further explained in detail based on the Examples concretely, but is not limited thereto.

[0030] Table 1 shows each component employed in Examples based on 60 parts by weight of NR and 40 parts by weight of BR.

TABLE 1

butadiene rubber (BR)		BR150B available from UBE Industries Ltd
silica		Utrasil VN3 available from Degussa Co Ltd
carbon black	A	Diablock N220 available from Mitsubishi Chemical Corporation
	B	Showblack N110 available from Showa Cabot Co Ltd
silane coupling agent		Si69 available from Degussa Co Ltd bis(3-triethoxysilylpropyl)tetrasulfen

TABLE 1 (continued)

Powdered article containing cellulose	A	Sumicellco available from Sumitomo Seika Chemicals Co Ltd (cellulose material: rice husks, average particle diameter 100-120 μ m)
	B	Sumicellco available from Sumitomo Seika Chemicals Co Ltd (cellulose material: rice husks, average particle diameter 400-600 μ m)
	C	Sumicellco available from Sumitomo Seika Chemicals Co Ltd cellulose material: rice husks, average particle diameter 40-60 μ m
process oil		Diana process PS32 available from Idemitsu Kosan Co Ltd
wax		Sannoxwax available from Ohuchi Shinko Kagaku Kogyo Co Ltd
antioxidant		Ozonone 6C available from Seiko Chemical Co Ltd
stearic acid		Kiri available from NOF CORPORATION
zinc oxide		Ginrei R available from Toho Zinc Co Ltd
sulfur		Sulfur available from Tsurumi Chemical Co Ltd
accelerator		NOCCELER NS available from Ohuchi Shinko Kagaku Kogyo Co Ltd

EXAMPLES 1 TO 10

[0031] After mixing the component, the amounts of which are shown in Table 2, in a Banbury mixer, the mixture was vulcanised for 45 minutes at 150°C to obtain the rubber compositions 1 to 10. The obtained rubber compositions 1 to 10 were evaluated by measuring the following experiments.

Experimental methods

(1) Hardness of rubber (Hs)

[0032] The hardness of the rubber was measured at 25°C by the method described in HIS K6301. From the viewpoint of handling stability and abrasion resistance on wet or dry road, Hs is preferably large. But from the viewpoint of performance on snow and ice it is not preferably too large. It may be 60 to 68.

(2) Abrasion test

[0033] Abrasion was measured by using a Lambourn abrasion test machine made by Iwamoto Seisakusho Co Ltd at the condition of surface rotating speed 50m/min, load weight 2.5 kg, amount of falling sands 15g/min, slip ratio 25% as abrasion 1 and slip ratio 50% as abrasion 2. The results were shown by using an index based on the following Comparative Example 1 as 100. The larger the index becomes, the more excellent the abrasion resistance becomes.

(3) Car performance

[0034] Studless tyres for truck and bus having treads of the rubber composition were prepared by the conventional method. The tyres were fitted to a truck having a weight of 10 tons, and the performances were evaluated at Hokkaido Nayoro test course by the following methods.

(i) Cornering time

[0035] At -13 to -4°C the running time was measured on a figure of eight shaped circular circuit of a few hundred meters length. The results are shown using an index based on the following Comparative Example 1 as 100. The larger the index becomes, the more excellent the cornering property becomes.

(ii) Climbing time

[0036] At -13 to -4°C in order to confirm the traction in the front and rear direction, the running time was measured on a climbing road in the test course. The results are shown by using an index based on the following Comparative Example 1 as 100. The larger the index becomes, the more excellent the traction property becomes.

(iii) Braking distance on ice

5 [0037] At -4 to -2°C running at 30 km/h, the braking distance on ice was measured. The results are shown by using an index based on the following Comparative Example 1 as 100. The larger the index becomes, the more excellent the braking property becomes.

COMPARATIVE EXAMPLES 1 TO 14

10 [0038] Except for the amount shown in Table 3, comparative rubber compositions 1 to 6 were obtained and evaluated same as in Example 1. The results are shown in Table 3.

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TABLE 2

		Example									
		1	2	3	4	5	6	7	8	9	10
carbon black	A	40	25	5	25	5	25	5	-	25	25
	B	-	-	-	-	-	-	-	20	-	-
silica		5	20	40	20	40	20	40	20	20	20
silane coupling agent		0.5	2	4	2	4	2	4	2	2	2
powdered article	A	3	3	3	5	5	8	8	5	-	-
	B	-	-	-	-	-	-	-	-	5	-
	C	-	-	-	-	-	-	-	-	-	5
process oil		3.5	2.5	1.5	3.5	2.5	5	4	2.5	3.5	3.5
wax		2	2	2	2	2	2	2	2	2	2
antioxidant		1	1	1	1	1	1	1	1	1	1
stearic acid		3	3	3	3	3	3	3	3	3	3
zinc oxide		3	3	3	3	3	3	3	3	3	3
sulfur		1	1	1	1	1	1	1	1	1	1
accelerator		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Hs (25°C)		62	63	62	61	62	62	62	62	62	62
abrasion	1	98	98	93	93	96	88	87	95	89	94
	2	93	92	88	86	85	80	81	90	83	89
car performance	traction property	107	111	113	117	116	119	120	117	119	116
	cornering property	105	111	113	113	114	116	116	112	112	113
	braking property	104	108	110	112	112	116	117	113	115	112

TABLE 3

		Comparative Example													
		1	2	3	4	5	6	7	8	9	10	11	12	12	14
carbon black	A	45	40	35	25	15	5	0	45	45	45	45	45	25	25
	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
silica		-	5	10	20	30	40	45	-	-	-	-	-	-	-
silane coupling agent		-	0.5	1	2	3	4	4.5	-	-	-	-	-	20	20
powdered article	A	-	-	-	-	-	-	-	1	3	5	8	15	1	15
	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
process oil		2	2	1.5	1	0.5	0	0	2.5	3	4.5	6	9.5	2.5	8.5
wax		2	2	2	2	2	2	2	2	2	2	2	2	2	2
antioxidant		1	1	1	1	1	1	1	1	1	1	1	1	1	1
stearic acid		3	3	3	3	3	3	3	3	3	3	3	3	3	3
zinc oxide		3	3	3	3	3	3	3	3	3	3	3	3	3	3
sulfur		1	1	1	1	1	1	1	1	1	1	1	1	1	1
accelerator		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Hs (25°C)		62	63	62	62	62	62	62	62	62	62	62	63	62	62
abrasion	1	100	99	99	100	99	98	97	98	98	95	92	82	99	77
	2	100	98	98	97	95	95	95	98	93	91	83	69	96	68
car performance	traction property	100	101	103	105	106	106	106	101	107	113	115	115	108	119
	cornering property	100	106	106	112	114	113	114	100	100	102	104	105	112	114
	braking property	100	100	102	103	103	103	104	102	105	110	111	113	103	116

[0039] As is clear from the results in Examples 1 to 7, decrease of the abrasion resistance of the rubber composition of the present invention is slight so the abrasions resistance is good and the composition is excellent in traction properties, braking and cornering.

[0040] As is clear from the results in Example 8, even if changing the type of carbon black, the excellent performances were shown similarly, and from the results of Examples 8 to 10, the powdered articles having an average diameter of

100 to 120 μm were excellent in balance of abrasion resistance on snow and ice.

[0041] As is clear from the results in Examples 1 to 7 and Comparative Example 14, if the amount of the powdered article containing cellulose is beyond 8 parts by weight, the abrasions performance is drastically lowered and during performances are not more improved.

5 [0042] By the present invention there is provided a rubber composition for a tyre tread, having low decrease in abrasion resistance and balanced performance of traction property, braking property and cornering property.

Claims

- 10 1. A rubber composition for a tyre tread comprising 100 parts by weight of at least one rubber component selected from the group consisting of a natural rubber, an isoprene rubber and a butadiene rubber, 5 to 45 parts by weight of a silica, 0.5 to 4.0 parts by weight of a silane coupling agent and 3 to 8 parts by weight of a powdered articles containing cellulose material.
- 15 2. A rubber composition for the tyre tread of claim 1, characterised in that the average diameter of the powdered articles is 20-600 μm .
3. A truck and bus tyre, characterised by a tread comprising the rubber composition of claim 1 or 2.

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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DATABASE WPI Section Ch, Week 9439 Derwent Publications Ltd., London, GB; Class A12, AN 94-313815 XP002107623 & JP 06 240052 A (SUMITOMO RUBBER IND LTD) , 30 August 1994 * abstract *	1-3	C08L9/00 C08L7/00 C08K3/36 B60C1/00
X	DATABASE WPI Section Ch, Week 9440 Derwent Publications Ltd., London, GB; Class A12, AN 94-322292 XP002107624 & JP 06 248117 A (SUMITOMO RUBBER IND LTD) , 6 September 1994 * abstract *	1-3	TECHNICAL FIELDS SEARCHED (Int.Cl.6) C08L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29 June 1999	Examiner Van Humbeeck, F
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